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ABSTRACT

This project studied the effects of personality, motivation, and reward on the learning process in two main ways: (1) a long term study, which examined school achievement and gain in school achievement over a 1-year period, utilizing four major representative areas of school study; and (2) a short term study, which utilized a single lesson period and planned to relate learning not only to fixed personality and motivation traits, but also to emotional state at the time, stimulation of arousal, level of fatigue, amount of reward (contingent, noncontingent, immediate, and delayed), and changes of motivation level during the learning and recall (over a 2-week interval). The results of the long term study were statistically significant in support of several base hypotheses developed by the authors in previous research. Lessons in the short term study produced highly significant increments between pre-and posttests of achievement, but few differences were found for the diverse reward effects. The authors hope to utilize the extensive data for additional hypothesis testing in the areas covered by this research. (Author/PC)

I.R.M.A.

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FINAL REPORT

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EFFECTS OF PERSONALITY, MOTIVATION, AND REWARD ON LEARNING

by

Raymond B. Cattell, Keith Barton, Thomas Bartsch, and T. Emerson Dielman

A Non-Profit Organization For Basic Research In Personality And Social Psychology.

FINAL REPORT

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EFFECTS OF PERSONALITY, MOTIVATION, AND REWARD ON LEARNING

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Institute of Education, Bureau of Research

Note

This Report was originally due in August, 1973, but an extension of time through May, 1974, without additional funds was granted. Unfortunately, what was believed by the Accounting Office to be a small balance of unexpended funds proved nonexistent, and subsequent polishing and completion of certain conclusions in this Report were handled as far as possible by Professor Emeritus, R. B. Cattell without assistance.

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I. OVERALL DESIGN: THE LONG AND SHORT TERM STUDIES

The aim of this report is to summarize in more final perspective the detailed activities covered in the four annual reports already submitted. It will consequently in general not repeat the detailed underpinnings of evidence, which are available both in those reports and in the 25 published articles emanating from our four year undertaking.

The reader needs to be reminded, however, of the main goals, which were to evaluate the influence in school achievement of those factors in personality, motivation, home background, reward, and classroom stimulus which have hitherto been virtually unexplored as far as meaningful quantitative parameters are concerned. That is to say, although these influences have never been left out of the discussions of educators, not one-tenth of the exact study has been given to personality, motivation, and situation that has been given to predictions from intelligence and other cognitive capacities. One major reason for this is that it is only in the last decade that the structured (factorial) measurement of personality and motivation has reached a sufficiently organized and checked state to be effectively applied. The measurement of states, such as we need to explore the effect of the immediate classroom situation, is still more recent.

From the beginning (the 1969-70 report) the practice has been followed of dividing the total report into two justifiably very distinct parts, called for brevity, the Long Term and the Short Term studies. In the former, the aim has been to study levels and gains in school achievement over a long (one year) period, relating them to those determiners which may be considered relatively constant over such a period, namely, personality, ability, general motivation patterns, and home background.

This has been done on a fair scale once before, as reported in the book by Cattell and Butcher (1968), but what we call the Short Term study is more radically innovative. Here we take a single classroom period (with adjacent periods for before and after measurement periods) and ask what can be found about determiners of gain within a single typical classroom period. These determiners are the motivation state of the individual, the rewards offered him for learning, and his general emotional condition in regard to anxiety, depression, arousal, and fatigue.

II. ACCOUNT OF THE LONG TERM STUDY

A. Subjects. The subjects in the long term study of influences on school achievement and gain in school achievement have been boys and girls in midwest schools in the 13 to 17 year range. The analyses have been made for the sixth and seventh grades separately. For the sixth grade, N = 169, and for the seventh grade, N = 142, giving a total of 311.

B. Variables.

1. Independent (or predictor) variables in this study have been:

a. Within the Individual

1. Fourteen personality factors as measured by the High School Personality Questionnaire. These comprise such repeatedly checked structures as ego strength (C), surgency (F), super eg strength (G), premisia (I), radicalism (Q_1), the self sentiment (Q_3), ergic tension (Q_4).

2. Intelligence as measured by the Culture Fair Intelligence Tests.

3. Twenty factors in the motivation strength area, comprising sentiments, e. g. to home, school, self, and super ego, and drive strength, e. g. sex, fear, parental protectiveness, self assertion, each measured

separately for integrated and unintegrated strengths by appropriate batteries.

b. In the Individual Child's Environment

1. Objectively measured attitudes within the family of parents to children by the new FAM, using objective devices.

2. Child rearing practices in the given family using the instrument developed by Dielman.

2. Dependent (or criterion) variables in this study have been (a) the absolute level of achievement in school at the time, and (b) the gain in achievement over a year, both in five main areas, as follows: (1) social science, (2) English, (3) mathematics, (4) science, and (5) total scholastic performance. These have been measured both by the ETS Achievement tests and the school grades.

C. Analysis. The original intention was to make the whole of this analysis by correlational, factor analytic, and partial correlation methods, partly because the results could then be precisely compared with those in the book by Cattell and Butcher (The Prediction of Achievement, 1968) and partly because (apart from missing interaction effects) it gives a more immediately understandable idea of the relative magnitude of influences. However, an analysis of variance was also made later to examine the interaction effects that would otherwise be overlooked.

As indicated by the classification of variables, the main analysis is made by (1) treating personality, motivation, home background, etc., as the independent influences and achievement as the dependent variable. But we also investigated (2) a year's change in scholastic performance as the dependent variable. This permits examination of possible causal connections in the opposite direction from those we are compelled on common sense grounds to assume in (1), namely, (3) through scholastic success or failure affecting

personality and motivation. These could be simultaneous with causal interaction from personality to achievement. (4) Finally, we examined some relations in which achievement was not the key variable but which indirectly bear on achievement. These are the relations of child personality to family attitudes and child rearing practices, in a three cornered correlational analysis.

D. Results.

1. General Overview: Correlational and ANOVA approaches. The relationships in (1) above, (personality and motivation against absolute achievement) were highly statistically significant in virtually all possible breakdowns. The support for specific hypotheses about certain personality predictor variables made by Cattell and Butcher was strong and the outcome was particularly clear in regard to their over-all evaluation that close to one-fourth of the variance of the achievement (dependent) variable could be accounted for by intelligence, one-fourth by personality differences, and one-fourth by motivation--leaving one-fourth to influences extraneous to the individual concerned. Of couse, the individual child's personality already incorporates effects of some of the environment, and there are, therefore, many technical problems in deciding how to partial out environment from person sources. However, the fact remains that we are able to confirm (a) the remarkably high estimate of the Cattell and Butcher book (1968) that close to three-fourths of the total variance in scholastic achievement can be accounted for by a sufficiently comprehensive measurement of the individual child personality, and (b) that the three modalities of trait are about equally important, though motivation here, as in the earlier studies (perhaps through lower validity of measurement) does not quite reach its full one-third of the predictable variance.

2. More Detailed Account of Prediction of Levels of Achievement in Specific Areas. The statement that each trait modality accounts for about one-third of the predictable variance supposes that we have a rationale for handling any inter-correlation which exists among the three modalities of predictors. In the Cattell and Butcher studies they turned out to be virtually independent, the only inter-modality correlations of even moderate significance being those of personality with motivation, due largely to the self sentiment and super ego being measured in both, though through different instrumentalities. Essentially the same general degree of independence of the three modalities of predictors was found here and essentially the same pattern of correlations. The correlations comparable with those of Cattell and Butcher (1968) are shown separately for the two grades in Table 1.

TABLE 1

CORRELATIONS OF PERSONALITY AND ABILITY VARIABLES WITH ACHIEVEMENT

ETS Tests	A	B	C	D	E	F	G	H	I	J	O	Q_3	Q_4	Q_4	CFIQ
Grade 6 (N = 169)															
Social Studies	21†	57†	-04	15	-07	05	25†	05	02	00	02	-01	11	24†	44†
Science	20†	52†	03	-02	-08	-01	20†	08	08	02	-06	04	09	11	38†
Mathematics	26†	60†	-04	08	-06	09	28†	16*	-05	-08	-09	-10	06	11	60†
Reading	24†	60†	05	11	-09	06	41†	08	07	-01	-06	-03	11	12	52†
Grade 7 (N = 142)															
Social Studies	08	50†	18†	02	05	03	28†	08	-14	-17*	-19*	-06	24†	-04	47†
Science	07	55†	15*	06	11	10	26†	06	-15*	-20†	-19*	-08	15*	-02	53†
Mathematics	09	53†	23†	-05	22†	05	31†	17*	-21†	-23†	-31†	-13	19*	-03	66†
Reading	08	62†	21†	00	12	03	40†	13	-09	-12	-22†	-03	17*	-06	65†

*$p < .05$. †$p < .01$. *Note.*—Decimals are omitted.

The corresponding correlations for the ergic tension and sentiment strength factors in the School Motivation Analysis Test (SMAT) are shown in Table 2.

These results will be compared in a moment with hypotheses and earlier findings. Meanwhile, it is desirable to examine exhaustively the question of independent action of the modalities. The partial correlations that we

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TABLE 2

CORRELATIONS BETWEEN MOTIVATION VARIABLES AND ACHIEVEMENT, GRADE 6 (N = 169)

ETS Achievement Tests	Motivation Variables (SMAT)														
	Assertiveness			Sex			Fear			Narcism			Pugnacity		
	U	I	T	U	I	T	U	I	T	U	I	T	U	I	T
Social Studies	02	19*	13	15	16*	13	03	20†	14	-01	07	04	-05	36†	20†
Science	00	07	14	00	20†	13	15	17*	22†	08	11	12	-09	22*	07
Mathematics	-03	09	03	00	20†	13	06	14	14	-14	13	-02	-14	34†	12
Reading	03	19*	09	10	19*	20	15	29†	30†	14	23†	23†	-18*	36†	09
	Protective ness			Self-sentiment			Super Ego			School Sentiment			Home Sentiment		
	U	I	T	U	I	T	U	I	T	U	I	T	U	I	T
Social Studies	00	08	04	10	30†	12	02	40†	26†	-07	23†	08	08	13	14
Science	-07	14	07	00	37†	24†	-02	31†	18*	-02	27†	15	-05	12	02
Mathematics	06	17*	15	07	29†	13	-04	32†	17*	-01	24†	13	-13	21†	01
Reading	10	15	17*	-09	49†	26†	-01	43†	26†	05	33†	24†	-38	17*	03

CORRELATIONS BETWEEN MOTIVATION VARIABLES AND ACHIEVEMENT, GRADE 7 (N = 142)

ETS Achievement Tests	Motivation Variables (SMAT)														
	Assertiveness			Sex			Fear			Narcism			Pugnacity		
	U	I	T	U	I	T	U	I	T	U	I	T	U	I	T
Social Studies	04	19*	15	-07	23†	12	21†	05	20†	01	25†	17*	-02	25†	15
Science	00	23†	15	01	27†	20†	19*	15	24†	04	17*	14	-11	28†	10
Mathematics	08	27†	23†	00	42†	30†	19*	13	22†	04	24†	18*	00	28†	19*
Reading	-03	27†	15	-13	43†	22†	29†	16	32†	02	31†	22†	-24†	28†	00
	Protective-ness-			Self-sentiment			Super Ego			School Sentiment			Home Sentiment		
	U	I	T	U	I	T	U	I	T	U	I	T	U	I	T
Social Studies	08	20†	18*	03	33†	24†	-06	32†	17*	08	30†	24†	-15	25†	-00
Science	12	31†	28†	-01	31†	19*	-02	34†	20†	13	32†	29†	-18*	24†	-03
Mathematics	19*	20†	28†	04	32†	24†	-15	23†	04	11	32†	28†	-22†	25†	-06
Reading	21†	20†	30†	-63†	41†	24†	-02	42†	28†	15	39†	35†	-23†	34†	-03

can make are for intelligence alone, as fluid intelligence, g_f, in the culture fair I.Q., CFIQ; for the HSPQ 14 factors with or without including crystallized intelligence, B; for the ten motivation factors in SMAT; and for the separate integrated (I) and unintegrated (U) components in SMAT.

The results are set out exhaustively of most possible and all theoretically relevant combinations in Table 3.

3. Discussion in Light of Earlier Findings. Correlations are notoriously untrustworthy if one attempts to take them at face value on a given sample and population. But our capacity here to show that they are highly similar on both grades and again with the two samples in Cattell and

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Butcher, permits us to discuss the magnitudes of the influence of personality factors, and their differences with different areas of achievement with some confidence.

TABLE 3

PREDICTION OF SCHOOL ACHIEVEMENT FROM ABILITY, PERSONALITY, AND MOTIVATION MEASURES SIXTH GRADE ($N = 169$)

Model	Social Studies			Science			Mathematics			Reading		
	Incr. % σ^2	R_3	p	Incr. % σ^2	R^2	p	Incr. % σ^2	R_3	p	Incr. % σ^2	R^2	p
1. HSPQ + CFIQ + SMAT vs 0	.54	.00	<.001	.46	.00	<.001	.61	.00	<.001	.69	.00	<.001
2. SMAT vs 0	.38	.00	<.001	.32	.00	<.001	.38	.00	<.001	.58	.00	<.001
3. HSPQ vs 0	.40	.00	<.001	.35	.00	<.001	.44	.00	<.001	.46	.00	<.001
4. CFIQ vs 0	.19	.00	<.001	.15	.00	<.001	.36	.00	<.001	.27	.00	<.001
5. B vs 0	.33	.00	<.001	.27	.00	<.001	.36	.00	<.001	.36	.00	<.001
6. HSPQ − B vs 0	.23	.00	<.001	.16	.00	<.001	.19	.00	<.001	.28	.00	<.001
7. I vs 0	.35	.00	<.001	.29	.00	<.001	.32	.00	<.001	.55	.00	<.001
8. U vs 0	.04	.00	.775	.04	.00	.760	.07	.00	.420	.10	.00	.118
9. CFIQ + B vs 0	.35	.00	<.001	.29	.00	<.001	.47	.00	<.001	.41	.00	<.001
10. HSPQ + CFIQ + SMAT vs CFIQ + SMAT	.54	.43	.013	.46	.36	.036	.61	.51	.008	.69	.64	.132
11. HSPQ + CFIQ + SMAT vs CFIQ + HSPQ	.54	.42	.063	.46	.37	.268	.61	.53	.174	.69	.50	<.001
12. HSPQ + CFIQ + SMAT vs HSPQ + SMAT	.54	.53	.124	.46	.45	.165	.61	.55	<.001	.69	.66	.001
13. HSPQ + CFIQ + SMAT vs CFIQ + SMAT + B	.54	.49	.573	.46	.42	.616	.61	.56	.297	.69	.66	.422
14. CFIQ + SMAT + B vs CFIQ + B	.49	.35	.007	.42	.29	.047	.56	.47	.057	.66	.41	.000
15. CFIQ + SMAT vs CFIQ + U	.43	.22	<.001	.36	.20	<.001	.51	.40	<.001	.64	.37	<.001
16. CFIQ + SMAT vs CFIQ + I	.43	.40	.764	.36	.32	.541	.51	.48	.372	.64	.60	.108
17. CFIQ + HSPQ + I vs CFIQ + HSPQ	.50	.42	.019	.43	.37	.093	.58	.53	.108	.65	.50	.000
18. CFIQ + HSPQ + U vs CFIQ + HSPQ	.46	.42	.401	.40	.37	.514	.56	.53	.483	.58	.50	.010
19. CFIQ + I vs CFIQ	.40	.19	<.001	.32	.15	<.001	.48	.36	<.001	.60	.27	<.001
20. CFIQ + U vs CFIQ	.22	.19	.800	.20	.15	.396	.40	.36	.552	.37	.27	.007
21. CFIQ + HSPQ vs CFIQ	.42	.19	<.001	.37	.15	<.001	.53	.36	<.001	.50	.27	<.001
22. CFIQ + HSPQ vs CFIQ + B	.42	.35	.098	.37	.29	.132	.53	.47	.090	.50	.41	.016
23. CFIQ + (HSPQ-B) vs CFIQ	.34	.19	.002	.27	.15	.027	.46	.36	.017	.43	.27	<.001
24. CFIQ + B vs CFIQ	.35	.19	<.001	.29	.15	<.001	.47	.36	<.001	.41	.27	<.001

PREDICTION OF SCHOOL ACHIEVEMENT FROM ABILITY, PERSONALITY, AND MOTIVATION MEASURES SEVENTH GRADE ($N = 142$)

Model	Social Studies			Science			Reading			Mathematics		
	Incr. % σ^2	R^2	p	Incr. % σ^2	R^2	p	Incr. % σ^2	R^2	p	Incr. % σ^2	R^2	p
1. HSPQ + CFIQ + SMAT vs 0	.51	.00	<.001	.55	.00	<.001	.69	.00	<.001	.76	.00	<.001
2. SMAT vs 0	.39	.00	<.001	.43	.00	<.001	.45	.00	<.001	.64	.00	<.001
3. HSPQ vs 0	.37	.00	<.001	.40	.00	<.001	.43	.00	<.001	.51	.00	<.001
4. CFIQ vs 0	.22	.00	<.001	.29	.00	<.001	.43	.00	<.001	.42	.00	<.001
5. B vs 0	.25	.00	<.001	.30	.00	<.001	.28	.00	<.001	.38	.00	<.001
6. HSPQ − B vs 0	.20	.00	.008	.21	.00	.004	.27	.00	<.001	.25	.00	.001
7. I vs 0	.34	.00	<.001	.41	.00	<.001	.41	.00	<.001	.58	.00	<.001
8. U vs 0	.08	.00	.398	.09	.00	.267	.13	.00	.073	.23	.00	<.001
9. CFIQ + B vs 0	.29	.00	<.001	.36	.00	<.001	.46	.00	<.001	.50	.00	<.001
10. HSPQ + CFIQ + SMAT vs CFIQ + SMAT	.51	.44	.451	.55	.49	.574	.69	.61	.041	.76	.73	.345
11. HSPQ + CFIQ + SMAT vs CFIQ + HSPQ	.51	.38	.144	.55	.44	.208	.69	.55	.004	.76	.59	<.001
12. HSPQ + CFIQ + SMAT vs HSPQ + SMAT	.51	.50	.169	.55	.54	.134	.69	.60	<.001	.76	.73	<.001
13. HSPQ + CFIQ + SMAT vs CFIQ + SMAT + B	.51	.46	.654	.55	.51	.771	.69	.61	.029	.76	.74	.487
14. CFIQ + SMAT + B vs CFIQ + B	.46	.29	.019	.51	.36	.036	.61	.46	.003	.74	.50	<.001
15. CFIQ + SMAT vs CFIQ + U	.44	.28	<.001	.49	.32	<.001	.61	.49	<.001	.73	.54	<.001
16. CFIQ + SMAT vs CFIQ + I	.44	.39	.372	.49	.48	.969	.61	.57	.208	.73	.69	.056
17. CFIQ + HSPQ + I vs CFIQ + HSPQ	.46	.38	.140	.53	.44	.015	.63	.55	.018	.73	.59	<.001
18. CFIQ + HSPQ + U vs CFIQ + HSPQ	.44	.38	.396	.46	.44	.869	.61	.55	.128	.65	.59	.019
19. CFIQ + I vs CFIQ	.39	.22	<.001	.48	.29	<.001	.57	.43	<.001	.69	.42	<.001
20. CFIQ + U vs CFIQ	.27	.22	.382	.32	.29	.714	.49	.43	.170	.54	.42	.001
21. CFIQ + HSPQ vs CFIQ	.38	.22	.004	.44	.29	.005	.55	.43	.004	.59	.42	<.001
22. CFIQ + HSPQ vs CFIQ + B	.38	.29	.123	.44	.36	.258	.55	.46	.020	.59	.50	.015
23. CFIQ + (HSPQ-B) vs CFIQ	.32	.22	.150	.37	.29	.205	.54	.43	.010	.52	.42	.018
24. CFIQ + B vs CFIQ	.29	.22	<.001	.36	.29	<.001	.46	.43	<.010	.50	.42	<.001

In Table 1 we see a gratifying precision of support for the earlier findings, in that super ego strength, G, and self-sentiment development, Q_3, were positive and important. Certain personality effects were evident in the seventh grade that were not shown in the sixth, and since one year of age difference could scarcely account for this, we must raise the hypothesis that a difference of main teacher and of class "syntality" is responsible. At any rate, in the seventh grade achievement was increased also by low guilt proneness (O-), harria (I-), and zeppia (J-), which make psychological sense if we suppose a somewhat more harsh atmosphere there. In general, the culture fair intelligence test predicts mathematics better and the traditional crystallized intelligence does better on social studies (comparison of CFIQ and factor B in Table 1).

In the motivation area (Table 2) self sentiment, super ego, and parental protective erg tension were positively related to achievement as also is fear (need security). In narcism and pugnacity, we see positive relation in the integrated component and a tendency to negative relation in the unintegrated. A word is necessary over the parental erg. As defined by content and its general meaning in psychology, it is a concern with protecting the helpless, with fostering young growing creatures, and with a predominance of kindliness in disposition. The only explanation we can give for the consistent positive influence of this drive lies in its constructive and fostering goals, which presumably come to apply to the growth of skills and knowledge in the individual.

The specification equations for personality, ability, and dynamic traits would, of course, not show just the same magnitudes as the correlations, being sometimes slightly lower and sometimes slightly higher. However, for theoretical purposes, our concern is with the correlations, for the same reason as we use in preferring to deal with correlated rather than uncorrelated factors, namely, that psychological meaning rather than statistical prediction alone is our goal.

Barton, Dielman, and Cattell, in articles in 1971, 1972, and 1973, have discussed the psychological meaning of these personality relations in more detail, including analysis also in terms of predictions from the second order factors anxiety and exvia-invia. Meanwhile, we shall summarize briefly by pointing out that as far as personality factors are concerned in both the sixth and seventh grades, the high-grade Ss over all areas were intelligent (B and CFIO), conscientious (G), and compulsive (Q_3+). In addition, in the seventh grade harria, zeppia, and low guilt played a part, and in the sixth grade warmheartedness (A) was also significantly related to grades in all areas. These results were identical to those obtained with achievement scores as criterion rather than teachers' grades (Barton, et al., 1971). There findings allow us to conclude that we have evidence that not only can personality variables significantly predict grades but that in general the same personality factors are important as those found in earlier studies of prediction of achievement.

In addition, evidence has been presented that although some personality factors significantly predict grades across all subjects for both sixth and seventh grades, other personality variables (e. g., factors A and J) are significant only for one grade. In order to determine whether this is a true developmental trend and not as hypothesized above, an expression of differences in teachers and class atmospheres in the different grades, replication of the above findings is necessary. A possible argument against the effect being due to teachers--and therefore presumably to syntality and children's age--is that different teachers were responsible for the different areas. Moreover, correlations between grade and personality variables across different areas remained consistent from class to class with respect to magnitude and direction of sign. Some personality factors were specifically related to grades in a single area, but no conclusions will be made about these until replication has confirmed their statistical significance.

It would be incautious, perhaps, to give a perfectly general answer to the question, "Do personality variables significantly increase the prediction of school grades over and above that amount of prediction achieved by using intelligence variables alone?" In the sixth grade, models 3 and 4 indicated strongly that personality variables did in fact produce such a significant increase for all subject areas. In the seventh grade, the same was true except for spelling and science. If the above question is rephrased in a more practical way--such as, does the HSPQ add significantly to the CFIQ in grade prediction?--then a glance at model 1 would convince most teachers of its usefulness in this respect. All in all, in the sixth grade, the amount of variance in grades accountable by IQ measure alone is just less than 20%, but this is increased to approximately 35% when the HSPQ is added. In the seventh grade, although IQ accounts for more of the variance in grades when the HSPQ is added than in the sixth grade, this increases to an average of 51% (from 30% for English, social studies, and mathematics) and to 27% (from 17% for spelling and mathematics).

4. The Prediction of Gain in Achievement. Still using the same predictors we now sought to predict gain. This has many problems which could not be fully solved by our design if it was also to be adequate to permit good solution of the primary question asked. The first problem is the appropriate measurement of gain itself, which, as Cronbach, Harris, Lord, and others have pointed out has several alternative solutions but none entirely satisfactory. The present writer has favored not partialling out the initial or final score from the gain score, since these may be expected psychologically to be legitimate determiners of gain, to be respected as part of the total naturalistic analysis. Partialling out is to be avoided also because it brings dependence on an estimate, where otherwise one would at least deal with concrete observations. Moreover, in getting rid of the error of measurement in the first score, one gets rid in the gain score of a much larger true variance too: the true score in the initial

measurement which psychologically may be influential. One must simply accept that a difference score is going to have twice the error variance of the absolute scores, and that no artifice will get rid of error once it is present. The real aim should be to make initial and final scores, and therefore gain scores, part of a single dependable equal interval scale.

In aspiring to this aim, one has to consider that (a) scale infelicities in "ceiling" and "floor" effects especially affect difference scores (Cattell, 1966), and (b) that the regression to the mean is due both to unreliability and to function fluctuation. We attempted to reduce ceiling anomalies by taking the before and after scores in a single standard score distribution, and then subtracted the score at the beginning of the year (in standard score units) from that at the end. This procedure resulted in no clearly significant correlations between any of the predictors and the gain scores. That is to say, 5% of the correlations were significant at the 5% level, and there does not seem any point in singling these out for discussion. Had funds permitted, we would have liked to pursue some further alternative ways of handling gain scores, since common sense suggests these gains must relate to personality and ability predictors in much the same way as do the absolute scores. But this was not possible.

An alternative approach, by analysis of variance instead of correlation, by Barton and Bartsch suggest that occasion 1 achievement variance accounted for so large a proportion of the occasion 2 and gain criterion variance as to mask other effects. The ANOVA design was actually set up in terms of examining three effects: (1) by occasions (1 and 2), (2) by level on each of the 14 personality factors, and (3) by level on each of the ten motivation factors. The dependent variable was, of course, achievement (on various school subjects), though out of curiosity we also tried the intelligence score and certain of our state measures (anxiety, arousal). Results of two sets of analyses are discussed here; one for the personality measures and one for the motivational variables. Analyses

were made separately for the dependent variables in achievement constituted by social studies, science, math, and reading.

The ANOVA designs for the personality studies consisted of a series of 2 (sex: male-female) by 2 (intelligence: high-low) by 3 (personality factors) by 3 (occasion) with occasion being the repeated measure. Intelligence scores were averaged over three occasions and split at the mean to form two groups. Second order personality sten scores were computed for exvia, anxiety, cortertia, and independence and averaged over three occasions. Subjects were trichotomized on these derived measures into high (sten $\geq$ 8), medium (sten $<$ 8 and $>$ 3), and low (sten $\leq$ 3) groups. For each second order dimension, an analysis for each of the four achievement measures was calculated; making 16 analyses in all. The results of these analyses have been presented in an article by Barton and Cattell now in press.

The ANOVA designs for relating gain to motivation consisted of a series of 2 (sex: male-female) by 2 (intelligence: high-low) by 2 (motivational factors) by 3 (occasion) with occasion, again, being the repeated measure. The treatment of intelligence scores was identical to that for the personality series. The motivational variables were chosen on the basis of their test-retest stabilities. Correlating each of the 20 motivational variables (integrated, I, and unintegrated, U, score for each of the 10 dynamic factors) with itself over three occasions indicated that coefficients for U scores were too low to justify their being averaged over occasions. This fluctuation suggests, along with other evidence, the unintegrated ergic tension scores behave more like psychological states than traits. It was decided to confine attention to I (integrated)scores. Analyses were completed for the ten dynamic factors measured by integrated devices. After averaging over three occasions, subjects were categorized into high and low motivational groups, on the basis of splits at the means. The sixteen analyses are contained in the published articles.

The most notable outcome of this series of sixteen analyses is that, to date, sex and motivation, but not intelligence, have been related to gain in achievement over time. More specifically, and in ANOVA terms, that is to say that interactions involving occasions were found for several of the SMAT factors and for sex of subject but not for the CIFQ. In this regard, the majority of the interactions involved gains in reading achievement. Here, improvement in the reading test was greater for females and for individuals scoring highly on the SMAT dimensions of mating and protectiveness. However, there were no higher interactions among sex of subject and the two SMAT dimensions. Gains in science and mathematics achievement were each related to a SMAT dimension. In the former, subjects scoring highly on the pugnacity erg exhibited more temporal improvement; while for the latter, individuals high on self sentiment gained more over time. One slightly more complex effect was found for social studies achievement where a significant sex (m/f) x mating x occasion interaction was found. Here the greatest gain was found for females scoring low on mating and males scoring high. The two remaining groups (female--high mating, and male--low mating) manifested less improvement over time.

5. Effect of Scholastic Success and Failure upon Personality and Motivation. From the beginning, the possibility has necessarily been kept open, theoretically, that any of the above relationships--by correlation or ANOVA--could be causal in either direction. Common sense and common observation suggest that the greater part of the achievement-personality relation is due to personality and intelligence affecting scholastic achievements. But evidence of some causal action in the opposite direction has already been found in regard to high anxiety and low achievement (Cattell & Butcher, 1968), and it seems likely that the same will hold for other traits. For example, over a four year interval, Cattell and Barton have shown that promotion in one's job is accompanied by an increase in dominance (E factor).

By a special planning of the long term study, we aimed to throw some light on this matter. The six testings over two years were arranged as shown in Diagram 1, where A is the achievement test and T the personality-motivation--ability testing session. A_1 actually took place in January, 1970, and T_3 in March, 1971, with a period close to three months intervening between the adjacent test occasions.

DIAGRAM 1

Temporal Spacing of Achievement and Psychological Test Measures

(1)	(2)	(3)	(4)	(5)	(6)
A_1	T_1	A_2	T_2	A_3	T_3
(January, 1970)					(March, 1971)

If we follow our assumption that causal action is in both directions--personality on achievement and achievement on personality--then two dependencies should be evident as follows: (1) The dependence of achievement on personality will be shown by a correlation of the value $(A_2 - A_1)$ with T_1, and similarly of $(A_3 - A_2)$ with T_2; (2) Any dependence of personality change upon information of achievement level will be shown by correlation of $(T_2 - T_1)$ with A_2, and of $(T_3 - T_4)$ with A_3. However, if we hypothesize additionally that an <u>increment</u> in achievement has powerful psychological effects, we shall examine additionally the correlation

$$r_{(A_2 - A_1)\,(T_2 - T_1)}$$

Again, as with our main study on increment scores, we failed to obtain any distribution of correlation coeffecients differing from chance. It must reluctantly be concluded that if real effects exist, as we believe, then present techniques and designs are not adequate. We suspect they are not adequate

because (a) our instruments are not yet sensitive and reliable enough for the double error in gain scores to be tolerated, (b) more attention must be given to seeking equal interval scale properties, and (c) time interval we could command in our experiment--three months between testings--is not long enough for changes in personality to affect performance or changes in performance to bring about measurable changes in personality.

6. The Relations of Personality and Achievement to Family Attitudes and Child Rearing Practices; by ANOVA. Nearly 30 years of systematic correlational and factor analytic work has produced well replicated scales in achievement, personality, and motivation (Cattell, 1973), and significant relationships have been demonstrated among them above. But the other types of variables we now planned to bring into relationship do not yet have such a well-checked foundation. In the child rearing practices area, the work of Barton and Dielman, following Sears and others, has recently begun, however, to give replication of structure. The analyses published from this research on responses of parents show some 16 distinct factors, in responses on child rearing practices, either by the mother or by the father. This initial work of Dielman was replicated here quite well on a second sample of some 300 parents. The dimensions of child rearing practice have been named tentatively as shown in Table 4.

As to total magnitude of influence between child rearing and child personality the mother's child rearing practices factor scores account for from 4 to 13% of the child's personality, depending on the trait involved. The child rearing dimension of high behavioral control, for example, correlates -.16 ($P < .01$) with Affectia, A, in the child, i.e. the child so raised is more reserved and aloof. Both Surgency, F, and Excitability, D, are also negatively related to High Behavioral Control ($r = -.15$ and $-.13$).

TABLE 4

List of Child Rearing Practice Factors Employed in the Current Investigation

1.	Fathers' Child Rearing Factor	I.	Preference for Younger Children
2.	Fathers' Child Rearing Factor	II.	Strictness of Discipline
3.	Fathers' Child Rearing Factor	III.	Low Father Involvement
4.	Fathers' Child Rearing Factor	IV.	Promotion of Independence--Low Child Orientation
5.	Fathers' Child Rearing Factor	V.	Dissatisfaction with Home Life
6.	Fathers' Child Rearing Factor	VI.	High Use of Sanctions in Child Rearing
7.	Fathers' Child Rearing Factor	VII.	Dislike of Intrusive Child Behavior
8.	Mothers' Child Rearing Factor	I.	Low Involvement--Dislike of Intrusiveness
9.	Mothers' Child Rearing Factor	II.	Lack of Warmth in M-C Relationship
10.	Mothers' Child Rearing Factor	III.	Low Father Involvement--Punitive Mother
11.	Mothers' Child Rearing Factor	IV.	High Goals--Early Socialization
12.	Mothers' Child Rearing Factor	V.	High Annoyability
13.	Mothers' Child Rearing Factor	VI.	Promotion of Independence--Low Child Orientation
14.	Mothers' Child Rearing Factor	VII.	Responsible Child Rearing Orientation
15.	Mothers' Child Rearing Factor	VIII.	Low Use of Sanctions in Child Rearing

Early authoritarian discipline was found to be the best predictor of dominance, E, in the child himself. Many other significant relations, which can be brought to bear on theories of development will be found in the articles concerned (Dielman, Cattell, and Rhoades, 1972; Barton, Dielman, and Cattell, 1974). However, even here it is not safe to assume the commonly expected

direction of causal action. For example, culture fair I.Q. (fluid intelligence) is associated -.23 with Early Authoritarian Discipline among the child rearing practices dimensions. Because of the high heritability of intelligence, it is surely more reasonable to assume here either that (a) low intelligence in the child requires and provokes more authoritarian direction , or (b) that low intelligence in the child bespeaks (from inheritance) low intelligence in the parent, which perhaps itself favors more authoritarian methods.

Child rearing practices were related also to the dynamic structure in the child as measured by the SMAT. Significant relations well above chance were found as reported in the article by Dielman, Barton, and Cattell entitled "The prediction of objective motivation scores from parents child rearing practices " (Journal of Genetic Psychology, 1974).

The possibility of explaining the three-cornered relations of the dynamics of the parents, in their objectively measured attitudes, to both the child rearing practices and to child personality trait measures was ensured by our design. However, the analysis of these relations was actually peripheral to our original plan and since computation was not reached at the time our grant expired, it is presently being undertaken by Professor Keith Barton, as a personal project at the University of Calfiornia.

In Section D. 1. above, an account has already been given of the supplementation of correlational by ANOVA treatments of the relation of achievement to personality, in terms of primary factors. While extending the analysis here we decided to examine relations also to the second order personality factors, combining the scores on the primaries according to an averaging of the weights found in several published second order analyses. However, since there was some fluctuation across samples, at that time, on second orders V, VI, and VII, etc., the analyses were confined to Secondary I, Extraversion-Intraversion, II, Anxiety, III, Cortertia, and IV, Independence.

In regard to Secondary I, a plot of relations showed clearly and significantly that extremes do significantly better than those with middle scores. Since extremes on temperament are known to have difficulties in social adjustment this could be explained by supposing that school work, to some degree, can be a compensatory interest for reduced social acceptance. However, there is also noticeable, as Bartsch points out, an agreement here with the correlational evidence that in young children better school performance goes with exvia, whereas by college student age the inviant individual (especially in the primary component Q_2, self sufficiency) does decidedly better for the same intelligence. Our hypothesis is thus one of a transition toward maximum scholastic achievement with invia as the individual reaches adolescence.

On the second order anxiety factor, a somewhat similar effect was discovered. The analysis of variance results agree with those of several correlational plot studies in showing a curvilinear relation in which high anxiety goes with low achievement, but with a slight rise of anxiety again at the high achievement end! However, articles setting these results out in detail (bibliography below) show interesting differences for particular subjects. For example, in mathematics better performance goes with reduced anxiety through the whole range of either variable.

Some complex interactions were found by Barton between exvia and anxiety levels, as follows.

Extraversion Analyses. In the case of social studies, an occasions x extraversion interaction effect was found ($p < .01$). A Tukey test revealed that both the inviant and exviant groups increased at a greater rate between occasions 2 and 3 than did those in the middle of the exvia-invia range. The only other interaction effect observed was a sex x occasions effect for reading scores. Here a breakdown of mean cell comparisons showed that the females

increased at a greater rate than did males, in the area of reading achievement. But the main finding is the consistency with which both high and low extraversion groups achieved at a higher level than the middle extraversion group over all subject areas.

In conclusion, it would seem that we have evidence to support the notion that extreme levels of anxiety (low or higher) are related to a relatively high achievement in social studies. But low anxiety was related linearly to high achievement in mathematics. In the case of science and reading once again low anxiety is related to achievement but only for males, not females. These results are consistent with Cattell and Butcher's (1968) and Cuppen's (1967) findings that "overachievement," i.e. relative to intelligence, is related to low anxiety.

The results of the extraversion analysis are consistent with past findings if the Ss in this experiment are considered to be at the critical age, around which there is a change in importance from extraversion to introversion, with respect to school achievement. Both Cattell and Butcher (1968) and Entwhistle (1972) have found that exviant primaries, notably A, affectia, or exvia as a whole, tend to be positively related to achievement up to about 16 and negatively in undergraduate or older populations. That is to say, when learning is done outside the social situation of the classroom, the inviant person does better. We would interpret the curvilinear relation we have found as an expression of the onset of this second, "private study" relationship on top of the social classroom effect favoring extroverts. The fact that interaction effects were found so definitely in our researches in this area suggests future researches should employ designs which examine sex, achievement area, intelligence, and developmental trend variables by ANOVA and by correlation plots.

These interactions are particularly evident in the anxiety area. Significant interaction effects were found for the dependent variables presented by social studies, science and reading. In the case of the social studies analysis, a significant sex and anxiety effect was found. A Tukey test (Winer, 1962) showed that the overall significance of this effect was mainly due to the fact that the female--low anxiety group scored highly on social studies. Since this sex-by-anxiety interaction did not occur in the case of the other three achievement areas (though other interactions did), no general importance is attributed to it, although it is possibly relevant to the case of social studies alone.

Turning to the science and reading analyses, the results were more complicated, as in both cases, there was a significant sex x intelligence x personality level x occasions interaction. A Tukey's test of the means involved in the science interaction, showed that the high intelligence male group who were also low in anxiety, achieved significantly higher on the science achievement test than did any other males on any occasion. The rest of the comparisons of means involved in the interaction effect revealed that in general the high intelligent group of both sexes achieved at a higher level than the low intelligent group but that this effect was greater for the male group.

Turning to the reading analysis, the sex x intelligence x anxiety level x occasions interaction was examined by applying a Tukey test. Results indicated that, as was the case in the science analysis referred to above, the low anxious males achieved at a superior level to all other males. For females, the high intelligent group did not differentially achieve as a function of their anxiety level.

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In terms of the social studies results, a significant interaction effect was noted between sex x anxiety level. Here, low anxious males scored higher than low anxious females. In the case of the mathematics results no interaction effects were found but there was a significant main effect for anxiety level (see Table 1) where the low anxious group scored higher on the mathematics test than did either the medium or high anxious Ss ($p < .05$).

III. ACCOUNT OF THE SHORT TERM STUDY

The aim of the "short term study" it will be remembered was to evaluate common determiners of learning gain in a typical classroom situation. As far as we know, this has not been done before with such an array of basic traits, common states, and manipulated conditions as we comprehensively covered here. For that reason, despite the absence of fewer positive conclusions than we had hoped for, the research has value in yielding the experience for future attacks which a pioneer study often provides.

In the first place, we retained the same measures of "fixed" personality, ability, and motivation traits as basic determiners as in the long term study. But in addition, we manipulated and introduced measures of mood state and motivation at the time of the classroom learning. We also manipulated reward, and measured effect of reward by evaluating tension reduction over the classroom period.

This study bristled with new methodological and experimental problems in terms of choice of learning material, measurement of mood states, the attachment of reward to given learning gains, and the sheer handling of so many determiners in an analysis of variance design. The reward relationships have previously been well worked out in laboratory learning experiments, but new problems arise if rewards have to be manipulated in an otherwise "undisturbed" classroom situation. Further, the introduction of reward

measurement by scoring ergic tension changes is entirely new and poses new experimental problems. The nature of these problems is best seen as we proceed to detailed statements about subjects, variables, and analysis. But it can be stated that the design is one in which both naturally occurring individual differences, in traits and states, and certain manipulatively produced differences in learning conditions were jointly examined in an analysis of variance design.

A. Subjects. The choice of subjects was to be that central and typical to the high school range. We took approximately equal numbers of boys and girls, averaging close to 12.5 years of age, and falling in the sixth and seventh grades of several Midwestern school systems.

The total number had to be decided by the requirements of the number of effects, which turned out to be nine, requiring $2^9 = 512$ cells. With four cases as a possible minimum in each cell, this defined the total as 2048, but actually 2596 boys and girls (1303 B; 1293 G) were measured, this total being usuable on certain sub-analyses. This number was eventually collected, care being taken to assure correct assignment of all cases to cells.

B. Predictors (Treatments). As stated above, we are concerned with some determiners that are "given" characteristics of the subjects and others that are manipulated conditions.

1. The personality source traits need no further description after the account in the long term study, since the same 14 source traits were used, the expectation being that essentially the same traits would relate to performance in a single classroom hour as over the school year.

2. Motivation Strength. Again the essential variables are the same as in the long term study, namely, six ergic tension levels (sex, pugnacity, fear, narcism, etc.) and four sentiments (to home, to school, to self, and to super ego values). However, special attention is given theoretically here to the unintegrated component measure in each of the ten dynamic

traits because evidence is accumulating (notably in the work of A. B. Sweney) that this represents the level on a changeable "motivational mood," such as we need most to measure in an hour's classroom learning period.

The examination of these variables as predictors includes both the absolute level, and the change in level (as a measure of reward by tension-reduction).

3. General Mood Level at the Time. A distinction has been made in recent work on psychological states by Cattell, Curran, Nesselroade, and others, between general mood states and dynamic states (such as are represented by the unintegrated components above). The general mood level instrument is based on questionnaire items factor analyzed by both dR- and P-techniques, and covers eight independent state dimensions: arousal, anxiety, fatigue, depression, etc.

4. Fatigue as an Externally Imposed Condition. In addition to measuring fatigue, as in (3) above, we manipulated it as an effect by having half the subjects experimented upon in mid-morning and half in mid-afternoon. This assumes that fatigue increases with hours of activity, and that children in mid-afternoon will be more fatigued than those in mid-morning.

5. Arousal by Music. A second state, manipulated as well as measured, was that of arousal, which has been hypothesized to be an aid to learning. The manipulation of the level of the anxiety state was also considered (by dwelling on illnesses, nuclear warfare, etc.). But although Cattell, Scheier, and Grinker (1961) had previously showed successful changes from this source, the recent atmosphere of allergy to psychological manipulation of subjects caused us to avoid this, at any rate with children.

A preliminary pilot experiment had shown that arousal level (as measured by our scales) could (at a low significance) be affected by martial band music.

Of course, this might affect other moods too, but if so, our eight dimensional scale would be capable of showing it, so that learning effects could be referred to these too. A standard taped recording lasting eight minutes was the applied stimulus.

6. Effect of Reward, Contingent and Non-contingent, Immediate and Delayed. Initially an evaluation of several forms and dimensions of reward was planned, but difficult circumstances cut these down. From general learning theory we took the distinction between contingent and non-contingent reward, and of more immediate and more delayed reward. From the dynamic calculus (Cattell, 1957; Horn, 1966; Cattell & Child, 1974) we took the idea of stipulating reward in terms of reduction of particular drives (ergic tensions) and relating the reward to the condition of ergic tension in the individual at the time (since this could now be measured by SPIAT).

In the end, however, we had to settle for a monetary reward, meaning all things to all people. Furthermore, as discussed in more detail below under Procedure, the requirement of making reward uncorrelated with individual differences in talent upset the true value of the contingent-non-contingent distinction, so this factor in learning was not in the end properly exploited.

C. Dependent Variable or Criterion. Much thought was given to the choice of a learning task that would meet all theoretically required conditions, inherently and in regard to maniuplation. Originally, moreover, we envisaged examining learning of two kinds--conceptual and motor--but shortage of resources for so large a design as this required us to drop the second.

Since we wished to maintain maximum control of irrelevancies like teacher personality and method of presentation, we decided to use a standard talking movie. And since we could not be sure of the standard of pre-experimental experience at a given time unless we kept the content clear of ongoing school

education, we decided the themes must be those not normally in the school curriculum, though of the same type. To be reasonably sure that any effects discovered are not peculiar to one kind of content, it seemed desirable to have at least two. Moreover, in order to test our theories about the effect of relative strengths of individual interests (ergic tensions and sentiment strengths in SMAT) in relation to the interest specification equation for the appeal of the given topic, it seemed desirable to choose a topic not coldly academic but one involving strong motivations (loadings on major ergs and sentiments) in terms, at least, of common sense analysis and any previously available specification equations. The topics considered are listed in Table 5.

TABLE 5

Suggested Topics for Learning Task

1. Sports (basketball: to cover boys and girls interest)
2. National defense
3. Eating for good health
4. Safety measures against road accidents
5. Keeping pets--specifically a dog
6. Mechanical-scientific interests--specifically on construction
7. Comics--specifically drawings of Schulz
8. School grades--tips on answering examinations.

It will be noted that all eight of the above meet the requirement that the instruction we provided would be relatively new, so that our presentation would not be confounded with results of other ongoing instruction. But on grounds of good relations with the school, it was also necessary to choose

something the schools would feel to be useful, or, at least, innocuous, and for this reason, we eventually settled on number 4, Safety measures against road accidents,and number 5, Keeping pets. In what follows we shall refer to these briefly as the Safety and the Pets lessons.

In both, the material was so presented in the talking movie, that quite a number of definite questions could be asked, about both facts and relations, that would be scorable by multiple choice objective item presentations.

D. Procedure. The design called for quite a complex procedure, the following and recording of data from which taxed the experimenters considerably. To make this procedure intelligible it is necessary to keep in mind that nine distinct effects had to be mutually randomized and that certain sequences had to be observed, particularly in respect to learning and reward. The problems connected with the main manipulations, namely, (1) Reward, and (2) Arousal and fatigue, in fact, need precise discussion at this point, as follows.

1. The Problem of Investigating Reward Effects. It will be remembered that the theoretical plan for investigating reward effects was to examine three parameters: (1) Contingent and Non-contingent, (2) Immediate and Delayed, and (3) Closely versus Remotely related reward in terms of the ergic quality of the reward relative to the ergic tension high at the time of learning, as measured by SMAT. The last had to be given up, since we found the only practicable reward was money and the associated public praise for success.

Our original plan for the second was to produce delayed reward, between two testing sessions, by writing to the parents of the alleged successful children (the parents had already given their permission for the experiment) in the expectation that these children would then be further rewarded by parental congratulation. For various practical reasons--one of which was

that through randomization the reported "success" would correspond in only 50% of cases to what the child understood to be his immediate success--this was abandoned. Delayed reward here, therefore, means monetary reward but delayed ten minutes relative to immediate reward.

Contingent reward supposes that some individuals will be more successful in remembering the lesson than others, and that these will be rewarded and the less successful half not. Non-contingent reward supposes a random splitting of subjects and a reward to half of them which they are told is in no way associated with their performance. (Actually, they were told that the experimenter had money left over from the regular contingent rewards and wished to distribute it as a charity, by the toss of a coin.) In both cases, the effect of the reward is measured by a second testing on the lesson a week later, the gain and the absolute score on the second occasion to be compared with that on the first.

There is an unavoidable artificiality about some of these arrangements, which make comparison with the ordinary class lesson less than exact. For instance, the subject is exposed to the actual lesson only once, so that non-contingent reward (or, for that matter, contingent) cannot carry over any induced general attraction to the subject to later learning effects. It can act only by relative consolidation of whatever is learnt. Secondly, and more seriously, is the procedure in regard to telling the subject on which of his responses he was right and which wrong. As planned by the principal investigator a slide was to be shown immediately after the test on the lesson (on the first occasion) showing the correct answers, permitting the subject to know where he was right and where wrong. It is true there would then be immediate reward (through satisfactions to the self sentiment), so that the effects of the later planned rewards would not be the sole effect. But by

our reasoning the magnitude of the later rewards would multiply the immediate reward and would still be selective, reinforcing the correct and extinguishing the incorrect responses (when the test was represented a week later.) Dr. Dielman argued against this immediate information on correctness of response, on the above grounds and also because he thought it would not be possible to convince subjects that they were in the "successful" group (rewarded later) when they knew they had, say, only six correct answers out of 20. There was also the problem that they might then alter their responses before handing in their papers for scoring; though certain mechanical procedures might avoid this. (The principal investigator believed these to be only minor difficulties, to be handled by mechanisms of score sheet design preventing discussion of results among subjects as they sat in the classroom, while their papers were being scored.) In any case, in the actual test administration by Drs. Dielman and Barton, it proved impracticable to inform the subjects, when their response sheet was completed, as to which items they had done correctly. The whole of the subsequent results in the analysis below must be interpreted in the light of this fact that the effects on the dependent variable do not correspond to those most commonly brought about in learning experiments. The subject was rewarded--in both contingent and non-contingent--for what he had done, right or wrong. I can be argued that even though not rewarded for right answers, the amount of effort he had put into the lesson was being rewarded, and that in contingent reward he was told that this was a reward for his effort, whereas in the non-contingent it was not. It can perhaps also be argued that since most got more right than wrong answers, the reward favored correct learning. However, the principal investigator is of the opinion that it would have been better--and would be better in future researches--to follow his original design, and that some null results in the

present analysis are probably due to the poorer "leverage" from not tying reward more positively and precisely to correct responses individually.

Another debated issue of design was whether the "successful" in the contingent reward should actually be the more successful (the upper half of the score distribution) or a random half. The arguments against the former were (1) Practical: that there would not be time to score 30 papers in ten minutes (though the subjects handed them in and believed they were being scored), and (2) Theoretical: that it would be undesirable to confound talents and previous knowledge in the area with actual effort and learning during the hour. The principal investigator favored the latter somewhat, as the lesser of two evils. At worst, we would be rewarding talent plus greater effort, when greater effort alone was ideally to be rewarded, so that talent would enter as error. But by taking random individuals and telling them they are the successful, we reward lesser effort as much as greater effort. However, we do reward effort in the test--if that continues to mean anything in consolidation during the following week--and so this course of randomly chosen, talent-independent reward was adopted, because the alternative was impracticable without great expense in an immediate scoring team.

Thus half the subjects were rewarded (a dollar bill) as a contingent reward, being told they had done well (but chosen randomly); half of each were also given a non-contingent reward (a dollar bill--"we have this reward money over"); and half of each were rewarded immediately and half after another ten nimutes delay. A further discussion of this prodecure and its relation to results is given by Dr. Bartsch in Section F (Analysis) below. What has been said in general terms above about the reward system can be summarized in regard to the 16 cells (64 subjects in each) as defined in Table 6, which applies to half classes.

TABLE 6

Design of Allocation of Alternatives in Reward, With Independence of Actual Score

Subject	Immediate (+) or Delayed (-) Reward	Above Average in Actual Score	Contingent Reward	Non-contingent Reward
1	+	+	+	+
2	+	+	+	-
3	+	+	-	+
4	+	+	-	-
5	+	-	+	+
6	+	-	+	-
7	+	-	-	+
8	+	-	-	-
9	-	+	+	+
10	-	+	+	-
11	-	+	-	+
12	-	+	-	-
13	-	-	+	+
14	-	-	+	-
15	-	-	-	+
16	-	-	-	-

2. Sequences of Learning and Testing. Two main features of planning remain to be discussed, namely, the actual sequences of testing and the allocation of subjects in the total factorial design for analysis of variance in regard to the nine effects. Naturally, these are related and the first will only become fully intelligible in the light of the second.

As regards time intervals, the first session, being a testing on presumably "fixed traits" of intelligence, etc., needed no invariable time interval (other than being prior). But the remaining three sessions, 2, 3, and 4, were rigidly related for all subjects by being spaced one week apart. In accordance with general principles of design, notably as set out by Campbell and Stanley, half the subjects taking Session 2 took Session 4 without having taken Session 3.

The main experimental session was, of course, number 2, sessions 3 and 4 being only to test further gain in learning by consolidation (reminiscence) effects--over a longer and shorter interval-- in relation to the immediate learning measured in the second session (the first experimental session). In number 2, the experimental, manipulated session, the subject was first evaluated on his psychological states before learning, then on his prelesson knowledge of the topic (ACH I), then given the lesson followed immediately by an achievement retest (ACH II). For those classes (50%) exposed to arousal, martial music was played during this time. After the supposed immediate computer scoring of the results, the rewards of $1.00 were announced ($2.00 for those who got both contingent and non-contingent) on immediate reward basis. A time absorbing task, was then given, called the "driving maze" which had originally been designed to measure motor learning, but which now was not scored since we found (see above) that this would have rendered the total design too complex and demanding of subjects. Recipients of the delayed rewards (delayed only eight to ten minutes, however, beyond the three to four minute delay in the immediate reward) were then announced. The 8 states were then measured again (8 State II) as well as the motivation (ergic tension) levels in SMAT II, to see what the effects of the examination, the arousal, and the reward or non-reward had been on psychological states and ergic tension levels. This second session was thus <u>in toto</u> rather long--two hours and 55 minutes-- but bearable because of the variety, whereby "a change is a rest."

It will be recognized that for orderly records and discription of scoring, Sessions 2, 3, and 4 and their associated tests are so numbered, but in experimental terms they are 1, 2, and 3, and half the subjects went straight to 3 without taking 2. In terms of the subjects experiences, Session 4 is not a fourth session: it is the third session for those who had a two week gap between the learning and the first later retest.

As pointed out above, these sessions became finally clear only when the allotment of different subgroups in "cells" with specific experiences is described as follows in Section 3.

TABLE 7

Sequences and Contents in the Four Testing Sessions

First Session

1. Culture Fair Intelligence Test (CFIQ)	45 minutes
2. School Motivation Analysis Test (SMAT I)	75 minutes
3. High School Personality Questionnaire (HSPQ)	60 minutes

Being a measure of stable personality traits, Session 1 had no necessary time relation to later sessions, but usually preceded Session 2 by 2½ (one to four) weeks.

Second Session

1. 8 State Battery I	25 minutes
2. Achievement I on topic (half subjects on safety; half on pets)	15 minutes
3. Lesson (half on safety; half on pets)	15 minutes
4. Achievement II on topic (half on safety, half on pets) During 3 and 4, martial music (arousal) was played in half the classes	15 minutes

Table 7 (cont.)

5. Immediate reward given as individuals are told (a) which half successful (contingent) and (b) which half (random to a) are given in any case the non-contingent reward — 5 minutes

   Driving maze given here. This was not scored, but used simply to fill delay period between immediate and delayed reward. — 10 minutes

6. Delayed reward given to "delayed" half of the above rewarded individuals — 5 minutes

7. 8 State Battery II — 25 minutes

8. School Motivation Analysis Test (SMAT II) — 60 minutes

Third Session This followed Second Session by one week

1. 8 State Battery III — 25 minutes

2. Achievement on topic III — 15 minutes

3. School Motivation Analysis Test (SMAT III) — 50 minutes

Fourth Session This followed Session 3 by one week and was taken by all subjects

1. 8 State Battery IV — 25 minutes

2. Achievement on topic IV — 15 minutes

3. School Motivation Analysis test (SMAT IV) — 60 minutes

3. The Allotment of Subjects to the Specific Treatment Combination Cells. The placing of individuals in cells of the analysis of variance design depends partly on effects which derive from the subjects themselves, e. g. high or low intelligence, and partly from effects manipulated by the experimenter, e. g. arousal, fatigue, presence or absence of a learning session, topic of lesson, type of reward, etc. It is with the latter that we are here principally concerned.

First, it should be noted that we dealt with one lesson topic only in our analyses--safety--calling it the relevant lesson with relevant retestings;

while "pets" was, so to speak, the "placebo," used as an indifferent form of occupying in one group the time spent in the other on the relevant lesson. It would have been possible to make the study symmetrical in this respect, and to have retestings on the "pets" lesson irrelevant to the "safety" lesson; but our analysis did not proceed to this.

The nature of the alternative subject matters (topic), arousal, fatigue, nature of immediate post test, contingent, non-contingent, and delayed reward distributions is shown in Table 8. It will be seen, as stated earlier, that there are nine features with respect to which there are alternatives, so that the total number of subjects had to be some multiple of 2^9 (=512), and actually we took, as stated earlier, 2048 boys and girls (actually 2596 were accumulated, and are usable for certain analyses) making four subjects to each cell.

TABLE 8

Combinations of Nine Two-Alternative Treatments

(1) Type of Pre-Test	(2) Type of Lesson	(3) Degree of Fatigue	(4) Degree of Arousal	(5) Nature of Immediate Post-Test *
Pet	Pet	Morning	No music	Pet Safety
Pet	Pet	Morning	Music	Pet Safety
Pet	Pet	Afternoon	No music	Pet Safety
Pet	Pet	Afternoon	Music	Pet Safety
Pet	Safety	Morning	No music	Pet Safety
Pet	Safety	Morning	Music	Pet Safety
Pet	Safety	Afternoon	No music	Pet Safety
Pet	Safety	Afternoon	Music	Pet Safety
Safety	Pet	Morning	No music	Pet Safety
Safety	Pet	Morning	Music	Pet Safety

TABLE 8 (cont.)

(1)	(2)	(3)	(4)	(5)
Safety	Pet	Afternoon	No music	Pet Safety
Safety	Pet	Afternoon	Music	Pet Safety
Safety	Safety	Morning	No music	Pet Safety
Safety	Safety	Morning	Music	Pet Safety
Safety	Safety	Afternoon	No music	Pet Safety
Safety	Safety	Afternoon	Music	Pet Safety

*Each of the 32 cells in column five is further divided as follows:

Contingent Reward	Non-contingent Reward	Delayed Reward	Delayed Post-test 1	Delayed Post-test 2
No	No	No	Pet	Safety
No	No	No	Safety	Safety
No	No	Yes	Pet	Safety
No	No	Yes	Safety	Safety
No	Yes	No	Pet	Safety
No	Yes	No	Safety	Safety
No	Yes	Yes	Pet	Safety
No	Yes	Yes	Safety	Safety
Yes	No	No	Pet	Safety
Yes	No	No	Safety	Safety
Yes	No	Yes	Pet	Safety
Yes	No	Yes	Safety	Safety
Yes	Yes	No	Pet	Safety
Yes	Yes	No	Safety	Safety
Yes	Yes	Yes	Pet	Safety
Yes	Yes	Yes	Safety	Safety

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Since some treatments, e. g. music (arousal), morning and afternoon fatigue, could only be conveniently given to whole classes at a time, while others, e. g. reward, could (and in some cases, for due effect, must) be given by division of a class, the expression of Table 8, in terms of actual procedural arrangements, required supplementation, which is illustrated for those who wish to go into further detail by Table 9.

TABLE 9

More Detailed Illustration of Procedural Arrangements Deriving from Table 8

(a) Arrangements made with respect to whole classes

Lesson W_1 (A)								No Lesson (False Session) W_1 (B)							
Immediate Reward W_2 A				Delayed Reward W_2 B				Immediate Reward W_2 A				Delayed Reward W_2 B			
Arousal W_3 A		No Arousal W_3 B		Arousal W_3 A		No Arousal W_3 B		Arousal W_3 A		No Arousal W_3 B		Arousal W_3 A		No Arousal W_3 B	
* W_4A	W_4B	W_4A	W_4B	W_4A	W_4B	W_4A	W_4B	W_4A	W_4B	W_4A	W_4B	W_4A	W_4B	W_4A	W_4B
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

* W_4A and B are Fatigue vs. Non-Fatigue (Afternoon vs. Morning)

(b) Each of the 16 "types" of classes in (a) would now be divided into subsets according to the five subset manipulations, thus requiring $2^5 = 32$ subdivisions in each class. The rationale for these balancing of testings is given in text.

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TABLE 9 (cont.)

(b) Sequential Arrangement of Testings and Rewards

Topic Pre-Test S_1A								Topic No Pre-Test S_1B							
Immediate Lesson Retest S_2A				No Immediate Lesson Retest S_2B				Immediate Lesson Retest S_2A				No Immediate Lesson Retest S_2B			
Con. Reward S_3A		No Con. Reward S_3B		Con. Reward S_3A		No Con. Reward S_3B		Con. Reward S_3A		No Con. Reward S_3B		Con. Reward S_3A		No Con. Reward S_3B	
Non Con Rew S_4A	No Non Con Rew S_4B	Non Con Rew S_4A	No Non Con Rew S_4B	Non Con Rew S_4A	No Non Con Rew S_4B	Non Con Rew S_4A	No Non Con Rew S_4B	Non Con Rew S_4A	No Non Con Rew S_4B	Non Con Rew S_4A	No Non Con Rew S_4B	Non Con Rew S_4A	No Non Con Rew S_4B	Non Con Rew S_4A	No Non Con Rew S_4B
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

One Week, S_3A, Two Week Retest S_5B

The designation of individuals to categories and the "bookkeeping" concerning which categories were becoming adequately filled was carried out by programming the computer to turn out "narrative" cards describing the allotment category of each and every subject. The above model requires that one "squad" as we may call it, of 16 classes, will be repeated as many times as we need individuals in each cell. Through failure of some subjects to complete the two (or three) sessions, "holes" became evident, requiring special individual testing to give replacements in the third and fourth category.

In relation to the Long Term study, the subjects for which were entirely independent of the Short Term study, and who were gathered all in one school, the Short Term study was thus very demanding of subject hours. In fact, it

required typically three sessions (but sometimes two or one) of about two hours each from some 70 sixth and seventh grade classes, distributed over some 30 schools mainly in Illinois, but also in neighboring states.

As to the time arrangements of our data gathering procedures, the Long Term study fell from January, 1970, to about April, 1971, as set out in Diagram 1 above, while the Short Term study gathered data from January, 1971, until June, 1972. The latter were tested at the rate of two new classes every week. Typically, four different classes were being measured at one stage or another or their (typically) two week sequence in any one week. This meant roughly eight half days of testing per week and kept two psychologists continuously busy. Due to vacations, failures of individuals to appear for retesting, etc., the total testing, at first estimated to take eight months, took about 15, and left us with only 12 months for a vast amount of scoring and analysis.

E. More Specific Statement of Leading Hypotheses Prior to Analysis. Before proceeding to the actual analysis of data in the Short Term study, it is desirable to discuss the rationale for the analyses made. The statement of analysis of data is best divided into three parts: (1) Hypotheses to be examined; (2) Numerical relationships to be statistically examined; (3) Statistical analysis methods to be applied to the relations. This separation is justified by (a) the fact that space restrictions here preclude more than a fraction of the hypotheses actually entertained by us being set out. The hypotheses must be considered as illustrative only, though illustrative of what might currently be regarded as the most important; (b) The fact being that relations are of more primary consideration than the particular statistical methods to be applied to them, and therefore need stating first and in relatively complete form. Nevertheless, they are, of course, far from a complete set of possible relations between independent variables (or combination thereof), dependent, or among independent variables (so-called).

Hypothesis 1: That the amount of (a) immediate learning gain and (b) retention of learning, is related by significant functions to the motivation level at the time of learning, both in the E (ergic) and the M (sentiment strength) terms. (This requires the correlations to be examined of immediate gain, and of one week retention, to motivation scores on all ten factors, including the specific "subject interest" factor, at time of learning.) For example, we would specifically hypothesize that strength on achievement need, super ego strength, and self sentiment are positively related and strength on unintegrated sex and pugnacity are negatively related to immediate learning gain in the 'short term" classroom situation, as in the long term.

Hypothesis 2: That over and above the effect of motivation levels, the level of excitement (arousal), as provoked by current environmental stimuli, as well as the levels of anxiety and fatigue, affect both gain and retention. (Tested by correlation of the three state scores and the two manipulative state stimulus levels with immediate gain and with retention scores, with partialling out of motivation and personality scores.) More specific hypotheses are on record in our writings regarding what the relation to anxiety arousal and fatigue will be, but cannot be set out in this restricted space. However, the generic hypothesis is that higher arousal level will increase the learning gain for any given motivation level, by reason of its enhancing of the cognitive "reverberation," but will not affect retention, as will the motivation level.

Hypothesis 3: That the amount of applied explicit contingent reward is related to magnitude of learning and retention (analysis of variance and partial correlational analysis on presence and absence of explicit reward as an effect, in relation to one and two week gain).

Hypothesis 4: That the gain from incidental, non-contingent reward is significant, but by no means as great as from explicit reward. (Comparison of one and two week gain differences for high and low explicit and

high and low incidental reward conditions.) Both here and in 4, a sub-hypothesis is that the meaning of the reward, in terms of its appeal to (satisfaction of) this and that drive (as a vector of drive strengths) will influence the learning gain in proportion to its similarity as a profile vector of ergic tension reductions, to the profile of ergic satisfactions in the given learning acquisitions.

Hypothesis 5: That delayed reward produces less learning than immediate reward according to a specified formula (linear lapse with time will first be tried) and that this effect is interactive with that between explicit and incidental reward differences. (Comparison of one and two week gains under the two delay conditions.)

Hypothesis 6: That recall is better when the dynamic and general mood state score pattern at the time of recall is closer to that existing at the time of learning. (This can be examined by comparing both (a) similarity on single factors and (b) pattern similarity coefficients, on occasions I and II and I and III of individuals with high and low retention scores.)

Hypothesis 7: That children from families with higher scores on (a) total attitude-interest in the child, and (b) higher general cultural interests, will experience more gain from the first to the second week [III a T (3) - II a T (2)], relative to immediate learning gain, as a result of home rewards on disclosure of the goodness of performance on the first occasion.

These seven hypotheses are only a fraction of the totality of important theorems in relations to learning laws that can be examined through the relationships generated by the above complex design. For example, they do not yet touch the possibilities of examining interaction effects between

personality and motivation measures, nor do they yet cut into the intriguing issues of differential effects from levels existing on integrated and unintegrated components, as are now known to exist in motivation strength measures. Regarding interaction between personality and motivation, an example of a more specific hypothesis is that a positive interaction effect will be found between increase in ergic motivation level and increase on the super ego strength (Factor G) on the personality scales.

F. Design of the Analysis: List of Actual Relationships to be Examined for Significance and Magnitude. Before examining the relationships, it behooves us to collect and state in summary list form the measures which can be obtained, as elemental scores or as relationships of scores having particular meanings as psychological variables. These are given in Table 10.

TABLE 10

Elemental Variables Obtainable as Scores and Capable of Being Related

Dependent Variables. In terms of the primary analysis of the Short Term research gain in achievement is the main dependent variable, and is consequently so named here. However, several later analyses searched for intermediating relations in which one or another of what are described as Independent Variables, here, became Dependent Variables.

Number in Matrix Calculation Records	
1. Immediate Gain on Lesson Topic	Change from ACH I to ACH II
2. One Week Gain on Lesson Topic	Change from ACH I to ACH III
3. One Week Retention on Lesson Topic	Change from ACH III to ACH IV
4. Two Week Gain on Lesson Topic	Change from ACH I to ACH IV
5. Two Week Retention on Lesson Topic	Change from ACH II to ACH IV

TABLE 10 (cont.)

Absolute Level before Experiment

Pre-testing on topic (safety knowledge) at ACH I

Independent Variables

Absolutes and Means

(a) Traits

1	Intelligence
2-21	HSPQ; 14 primary and 6 secondary personality source traits (A through Q_4, and Q I through Q VI)

(b) States

16-37	SMAT, 22 Motivation level measures at Session 1 (1st) testing
38-59	SMAT, 22 Motivation level measures at Session 2 (2nd) testing
60-81	SMAT, 22 Motivation level measures at Session 3
82-103	SMAT, 22 Motivation level measures at Session 4
104-125	SMAT, 22 Motivation level measures at Session 5
126-147	SMAT, Mean level over retention period--Sessions 2 and 3
148-169	SMAT, Mean level over retention period--Sessions 2, 3, and 4
170-191	SMAT, Mean level over retention period--Sessions 3 and 4
192	Arousal state levels at Session 2, Measure 1
193	Arousal state levels at Session 2, Measure 2
194	Arousal state mean at Session 1
195	Arousal state mean at Session 2
196	Arousal state mean at Session 3
197	Arousal state mean at Session 4
198	Arousal state mean of 1, 2, and 3
199-224	Fatigue State Levels (as for arousal)
225-231	Anxiety State Levels (as for arousal)

TABLE 10 (cont.)

(c) Background Traits

232-237	Home Attitudes, Parents to Children, on the FAM Scales (six variables originally)
238-241	Home Atmosphere, Child Rearing Practices (four variables originally)
242	Biographical Data (10 variables on economic status, number of children, etc., inserted as 242a, 242b, etc.)

(d) Manipulated Conditions

243	Contingent Reward
244	Non-contingent Reward
245	Immediate vs. Delayed Reward
246	Applied Arousal (music)
247	Applied Fatigue (afternoon)
248	Relevant Lesson vs. Irrelevant Lesson (Pets)
249	Pretest vs. No Pretest

Derived: Difference and Ratio Scores

250-271	Reductions of SMAT tensions as reward measures (22 of them) from pretest to after reward
272	Changes of state level on arousal, pre to post 1st
273	Changes of state level on anxiety, pre to post 1st
274	Changes of state level on fatigue, pre to post 1st
275-296	Changes of SMAT, Session 2 to 3
297-318	Changes of SMAT, session 2 to 4
319-340	Changes of SMAT, session 2 to 5
341	Changes of state level on arousal 2 to 3
342	Changes of state level on arousal 2 to 4
343	Changes of state level on arousal 2 to 5
344-346	Repeat for anxiety
347-349	Repeat for fatigue

TABLE 10 (cont.)

The relationships may be divided into Independent-to-Dependent and Independent-to-Independent.

Relationships to be Examined (It has seemed best to state the plan, though, as described later, some were never reached before the analysis had to stop.)

(a) Independent to Dependent

1. Gain in Second (learning) Session (variables 1 and 6 on Dependent above) to Intelligence level
2. Gain in Second Session related to each of 14 HSPQ variables
3. Gain in Second Session related to each of 22 SMAT levels (tenth measure on Second Session)
4. Relation of gain to state (a) at 1, and (b) as change: 8 - 1

(b) Among Independent

1. Relations among intelligence, HSPQ, and SMAT mean levels (approximately 37 x 37)
2. Relations of 37 variables in 1, to sigma on state levels on anxiety, arousal and fatigue
3. Relations of 37 variables in 1, to sigma on state levels on anxiety, arousal and fatigue
4. Relations of magnitudes of state change on arousal and fatigue to manipulated conditions supposed to produce arousal and fatigue
5. Relations of ergic tension reductions on 22 SMAT variables to manipulated rewards expected to affect them

As to the statistical evaluative procedures for examining the significance and extent of these relationships, we felt we should not depend entirely on any single approach. However, it is clear that concerning the variables themselves, we have opted for meaningful factors rather than narrow behaviors, and the relations of gain will be to factored structures in personality, ability, motivation, and psychological states. Indeed, we feel it is ofter overlooked in purely applied or education analysis that it is important for any

real theoretical advance to retain the findings in terms of psychologically meaningful, simple structure factors, as far as traits, states, and certain aspects of environment are concerned. Fortunately, as far as personality, ability, motivation, and general states are concerned, we were able to build on a firm foundation of previous programmatic research, and only in, regarding to, dimensions in child rearing practices and parental attitude measures did we have to make a special full-scale factor analysis as a necessary preliminary to our main present analyses. Except, then, for these and a factor analytic check on the state structure, the analyses in the Short Term study could be made primarily by analysis of variance and by multiple regression. The gain by using analysis of variance, when it can be applied, is, of course, that interaction effects can be explored, and we shall therefore consider this analysis of variance approach first.

Since we do not wish to obtain orthogonality of the unmanipulated variables by artificial selection on our total population, the analysis of variance will be confined to those treatments that are orthogonalized by preplanning and manipulation, namely (1) delayed vs. non-delayed reward, (2) arousal (music) vs. non-arousal, (3) fatigue--high vs. low, (4) contingent vs. non-contingent reward, and (5) effect of one vs. two week lapse. In these cases, F-tests, and later t-tests, have been applied and interaction effects have been examined. However, the higher order interactions are so numerous that they becom(of uncertain significance and will not be pursued.

The second and later approach (still within independent-dependent relations, as was the first), is one of multiple correlation and canonical

analysis,[1] and this has been reached only in some instances. Whenever the predictors are (mutually oblique) factors, it was proposed to proceed to partial and multiple correlations which is the same thing as obtaining the loading of each factor on the dependent variable (by inverting the factor inter-correlation matrix, etc.). This could be done for meaningful subsets, such as personality and ability variables, motivation and state variables, and all combined. One could proceed to do the same for higher order factors among these.

To examine the relative contributions of the unmanipulated independent variables just discussed, and the manipulative conditions, we planned either to use multiple regression models for analysis of variance, or factor analysis of combined pre- and post-influence scores in a single score matrix.

C. Results. At the time of complete expenditure of available funds, in August, 1973, all Long Term study data had been completely gathered and completely analyzed. All Short Term data had been completely gathered, scored, and recorded for analysis; but the actual analysis was stopped in mid-career. The experimental data gathering for so complex and exhaustive a design as was presented by the Short Term study, was a tremendous undertaking and took the full time of two research associated for 2½ years --the previous, first year of the total research being given to preparation and the Long Term study. Only six months remained for the analysis and this proved quite inadequate for the volume of analysis to be done. Accordingly, the full design for the

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[1] Since our independent variables are meaningful as they stand, the multiple correlation would be more important for basic as contrasted with applied research. We planned originally, therefore, to begin, in fact, with the zero order correlations of all predictors with all dependent variables, but this was completed only for the Long Term study. As regards applied research, the nature of our dependent variables is so diverse, and so "accidental" to our particular study that there is little point in this Short Term research (it is otherwise in the Long Term research) in reaching total canonical correlations. What we ultimately need here is consideration of simply each dependent variable, in its own right and meaning in terms of its first order correlations with the predictors.

analysis of variance for the Short Term study was worked out by Research Associate (now Professor) Tom Bartsch. The number of effects, cells, and possible interactions, can be most comprehensively seen from his Diagram 2, attached here as a folder.

On the usual analyses Bartsch at first reported significant F ratios for the effect of experimental manipulations on the driver safety lesson, but ran into doubts, and disputes with other statisticians on the legitimacy of the interpretations. The number of possible comparisons of means is very large, and, in terms of available degrees of freedom, firm interpretations cannot often be made.

Accordingly, it was decided to break up the large, balanced factorial design for the analysis of variance and to proceed by a larger number of sub-analyses. In doing this, we realize we run into the possibility that the distribution of error will be spuriously biassed, in terms of the overall expected error distribution; but to take this risk has seemed the only way to setting down straightforward conclusions free of extremely complex qualifications. Such conclusions are at least testable by investigators able only to enter experiment with limited fractions of our total design.

One such analysis, carried out by Bartsch, is that of the effects of contingent and non-contingent reward on the gain from the learning session, i. e. between that and the second week (third session). It will be remembered that subjects were pre-tested on either the pet or safety instruments, and they were then shown a film on either pet or safety materials. Immediately following the film, subjects were given an immediate post-test, again on either the pet or safety material. At this time, two types of reward were administered in a balanced fashion, contingent and non-contingent. These types of reward have been described previously (pp. 26-30). After a week's

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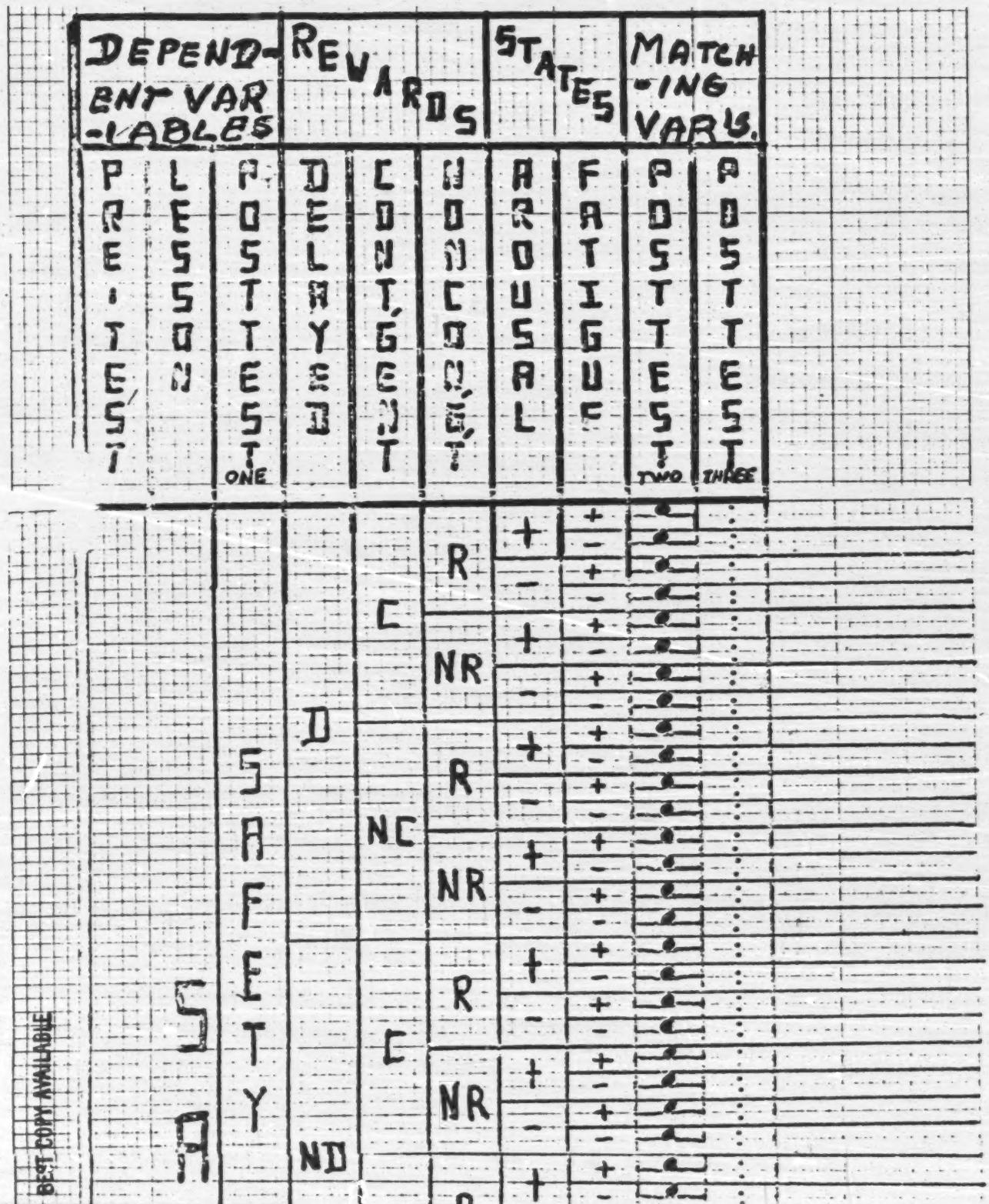
DIAGRAM 2

Indicating Variables, Effects, Number of Cells, and Possible Interactions



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SAFETY TESTS	D	C	R	+	+	
					−	
				−	+	
					−	
			NR	+	+	
					−	
				−	+	
					−	
		NC	R	+	+	
					−	
				−	+	
					−	
			NR	+	+	
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				−	+	
					−	
		NC	R	+	+	
					−	
				−	+	
					−	
			NR	+	+	
					−	
				−	+	
					−	
PETS	D	C	R	+	+	
					−	
				−	+	
					−	
			NR	+	+	
					−	
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		NC	R	+	+	
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interval, all subjects were again given a second (delayed) post-test on either the pet or safety material. The effects of reward on achievement were analyzed by a 2 (type of pre-test) x 2 (type of lesson) x 2 (type of immediate post-test) x 2 (presence or absence of contingent reward) x 2 (presence or absence of non-contingent reward) x 3 (occasions of measurement) factorial analysis of variance with repeated measures on the last factor. It must be noted that due to the balanced nature of the design with reference to the sequence of pet and safety tests and lessons, the effects of substantive interest are couched within certain contrived interactions. The results of the analysis of variance indicated the presence of these "contrived" interactions but did not, however, contain any evidence that the reward manipulations affected achievement test performance, i.e. interactions involving these manipulations did not reach significance.

This absence of evidence of effects for contingent or non-contingent reward (as opposed to no reward) is, in the principal investigator's opinion, most probably due to the execution of the design in such a way that the subject was unaware at the first test (Session 2) which of his responses was correct and which incorrect. Alternatively, as Bartsch suggests, it could also be due to the fact that no new <u>acquisition</u> (learning) trial, in which at least the individual's general effort and attention might be heightened by reward, followed this reinforcement experience. Thus, as pointed out in Section III, D, 1, above, differential reward could act only by producing differential <u>retention</u>--interpretable as due to consolidation through greater retrospective interest in the learning experience as a whole. And such an action would be discoverable only by the measures on the delayed post-test. Although this has been examined it also proves to be non-significant, a result that is not surprising in view of the very small effect that might be expected

on psychological grounds to a "retrospective consolidation" or "action of reward on reminiscence effect."

The results of this were successful in significantly altering performance on the achievement tests and the resulting performance increment was maintained over the week interval. Table 11 presents a subsection of the means from the total ANOVA as an illustration of this effect. An inspection of this table reveals that subjects who were exposed to the pet film exhibited an increase on the pet achievement test (11.5 to 21.5) from pre to immediate post condition. Since the subjects exposed to the pet film but tested on the safety material did not exhibit the same increment, testing effects may be ruled out as a sole explanation of gain in achievement.

TABLE 11

Means for the Pet Lesson Group (Selected out of Total Design) as a Function of Type of Reward (Contingent or Non-contingent) and Type of Substantive Achievement Test

Type of Pre-test	Substance of Lesson	Type of Immediate Post-test	Contingent Reward	Non-contingent Reward	Type of Delayed Post-test	Score on Sessions 2	3	4
Pet	Pet	Pet	No	No	Pet	11	21	19
Pet	Pet	Pet	No	Yes	Pet	12	22	20
Pet	Pet	Pet	Yes	No	Pet	12	21	20
Pet	Pet	Pet	Yes	Yes	Pet	11	22	19
Safety	Pet	Safety	No	No	Safety	12	14	14
Safety	Pet	Safety	No	Yes	Safety	12	14	14
Safety	Pet	Safety	Yes	No	Safety	15	15	15
Safety	Pet	Safety	Yes	Yes	Safety	12	13	13

At the present moment, the remaining analyses are not upon achievement as the dependent variable, but are concerned with relations among what at first (Table 10) were classed as dependent variables. The first such analysis was of the effect of fatigue upon psychological states, these states being considered intermediate variables, dependent as to fatigue, independent as to achievement gain. A second analysis was that in which arousal, by music, was the independent variable. The same design of analysis was used for both, as shown in Table 12. In these analyses due regard was paid to an effect not previously introduced--namely sex difference--because the full design would have had insufficient degrees of freedom. A balanced 2 x 2 x 2 factorial design was set up as shown in Table 12 to permit investigation of possible interactions with the sex difference.

TABLE 12

Design for Analysis of Fatigue Effects
(Repeated Similarly for Arousal by Music Effects)

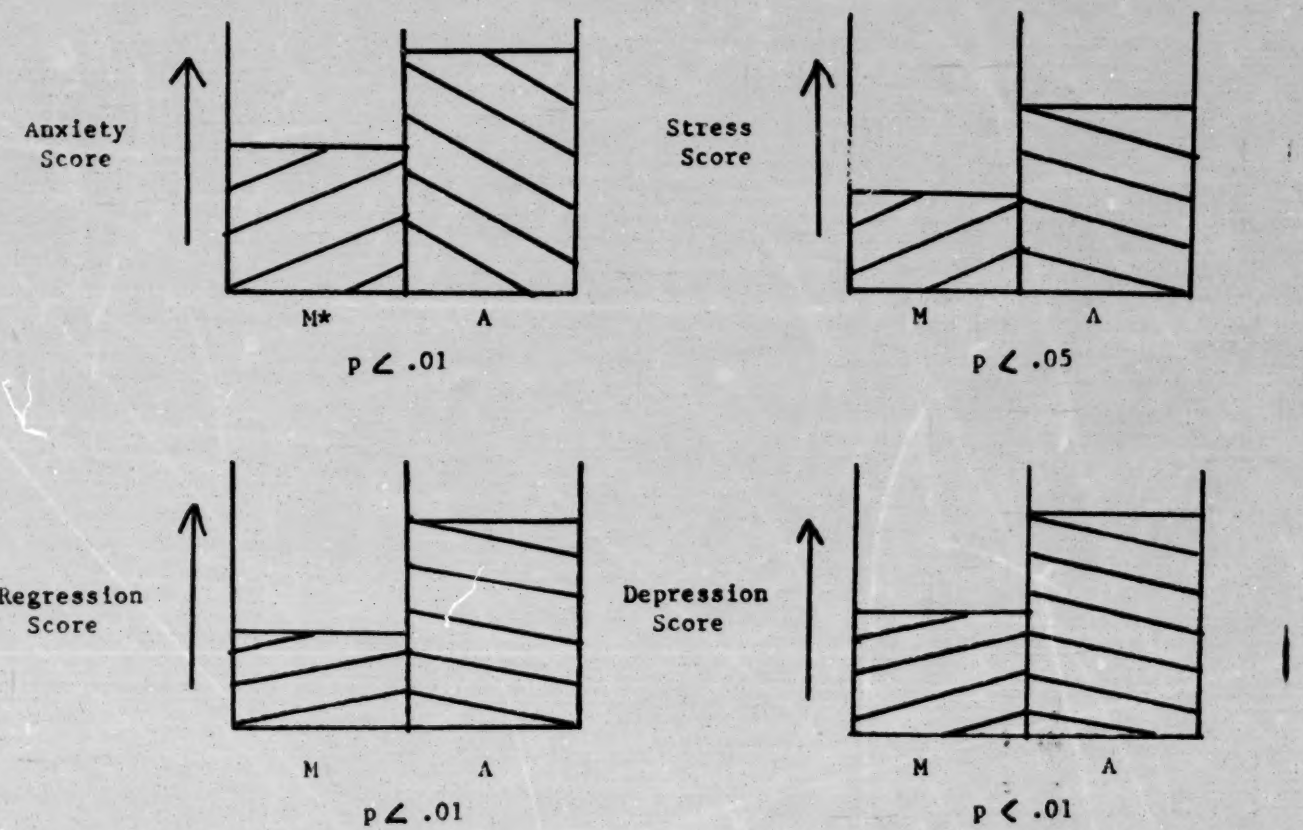
Sex	Arousal	Fatigue
Boys (N = 1305)	Music	Early Morning Test
	No Music	Late Afternoon Test
	Music	Early Morning Test
	No Music	Late Afternoon Test
Girls (N= 1293)	Music	Early Morning Test
	No Music	Late Afternoon Test
	Music	Early Morning Test
	No Music	Late Afternoon Test

The corresponding arousal design of course held time of day constant. The dependent variables in both analyses were the seven separately examined state scores on the Seven State Questionnaire. Several main effects and interactions were found, and these are shown graphically below. This diagram is meant for illustrative purposes only as the published articles spell out in detail the magnitudes of the gains or shifts.

DIAGRAM 3

Results of Analyses in Rough Graphical Form

Main Effects From Fatigue



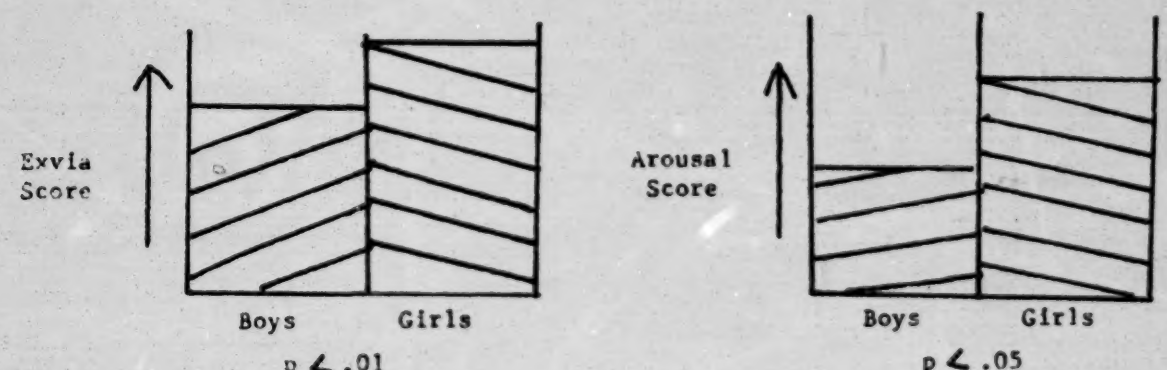
* M = Morning Test Session; A = Afternoon Test Session. These diagrams illustrate the changes in psychological states that occur from morning to afternoon.

It is readily evident that as far as fatigue as a manipulated (i. e. time of day) influence is concerned, a high proportion of the state measures show significant effects. Anxiety, depression, and regression increase at the $p < .01$ level of significance, and the stress state at the $p < .05$ level. As far as we know, this is the first direct and adequate demonstration of such an effect on depression and stress, though as long as forty years ago, Cattell (1935) using motor-perceptual rigidity as a measure of regression showed a steady increase of regression throughout the day. In later research on anxiety alone Cattell and Scheier (1961; also Cattell, 1957) gave evidence of a diurnal rhythm in which the psysiological indices of anxiety increased, as does the questionnaire measure used here, from morning to afternoon.

The main effects in regard to sex proved significant in the following states. It is surprising that anxiety is not among them since as far as measures of anxiety as a <u>trait</u> are concerned, boys have consistently been significantly lower than girls. Here, as Diagram 3 shows, the state scores show girls significantly higher on exvia and on general arousal level.

DIAGRAM 4

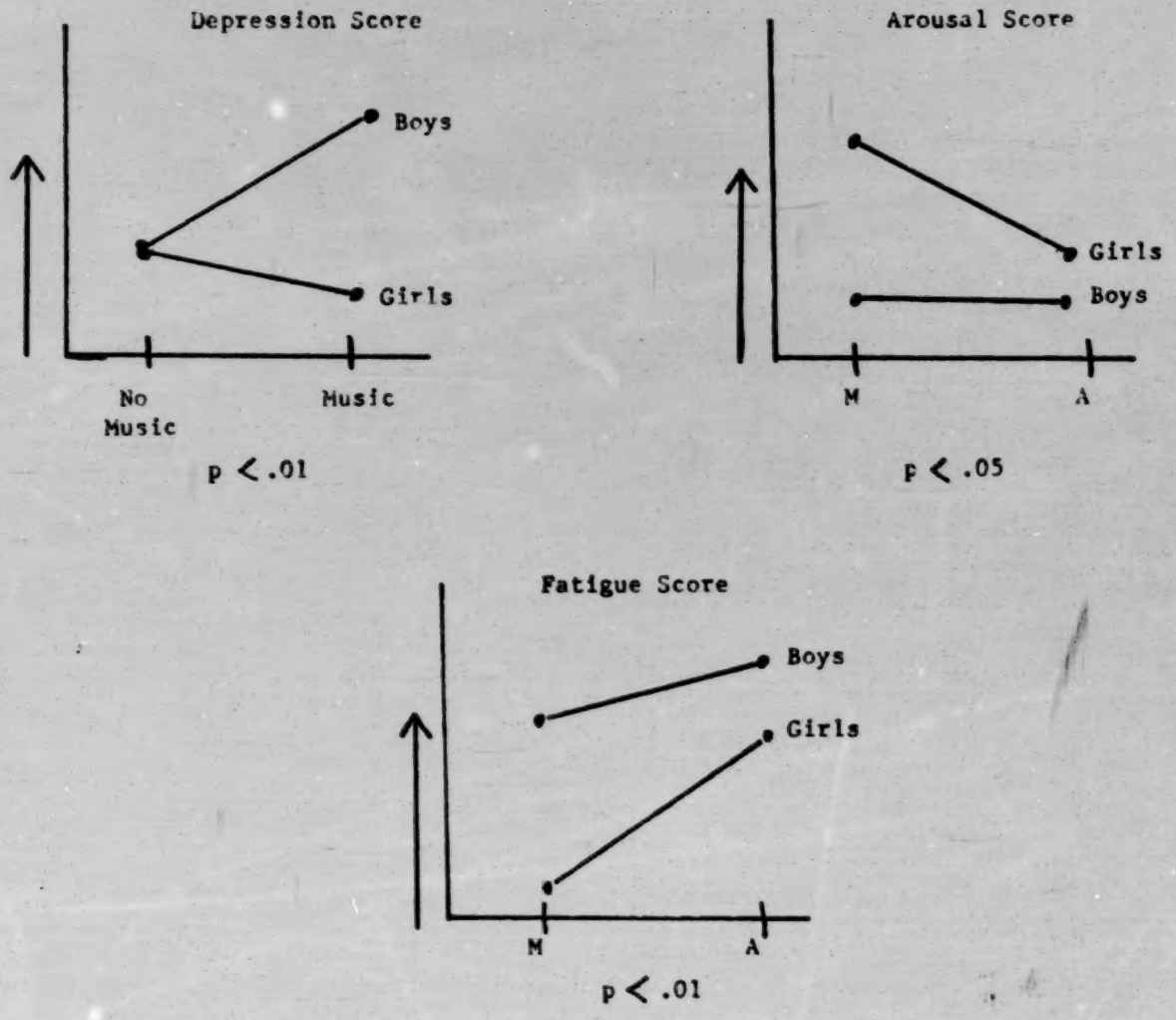
Sex Differences in State Level



The significant interaction effects are shown in Diagram 5. The generally higher arousal level in girls is accompanied by a tendency for it to drop throughout the day to a significant degree not found in boys.

DIAGRAM 5

Interaction Effects Observed in States



A very curious result is that martial music produces an increase in depression among boys, an effect not noticable in girls. The fact that the former were, at the time of testing, subject to the draft seems an over-simple

explanation! Finally, we notice that girls increase more in fatigue in the afternoons, a result which one is tempted to explain in conjunction with their greater arousal level in the mornings.

The above are the relationships in the Short Term study so far examined and evaluated, but they are obviously only a small fraction of the possibilities considered in our hypotheses set out in Section E, or of the possible inter-relations among the variables listed in Table 10. In our opinion, the most important of these relations still to be examined from the data we have recorded are:

(1) A further examination of the relation of forms of reward to achievement. Although a null result has been reported above with respect to the main one week gain, it is still worth while to examine the two week gain. Interaction effects also remain to be fully examined as well as a possible difference of delayed and non-delayed reward.

(2) Although we have examined, and found positive effects for, the influence of music and hour of day upon arousal and fatigue, we have not yet examined the effects of these latter, as state measures, upon achievement.

(3) Instead of taking the manipulated reward itself, we can study the hypothesized <u>effect</u> of the reward as measured in tension reduction magnitudes on the motivation analysis test. That is to say, gain is to be related to the differences of Sessions 1 and 2.

(4) Expanding (2) above, there are a whole series of state-to-achievement gains (immediate and delayed) to be examined. These include relating gain to level of all seven states on the Seven State Battery.

(5) Although the Long Term study has shown highly significant relations of characters of the individual--personality, intelligence, and motivation--to achievement, no one of the approximately 35 individual difference factors

has yet been related to learning gain in a single lesson, as in the Short Term data.

(6) A substantial number of psychologically important relations remain to be investigated among the "predictors" themselves. These include (a) the higher order factors and relations between personality and motivation variables, (b) the relation of occasion-to-occasion variability on the state measures to personality variables. Possibly also variability on the dynamic (SMAT) factors (and even the personality factors themselves) is a general trait which is related to HSPQ mean measures, e. g. on ego strenth, C.

(7) The fact that no relation has been found between reward and gain, and the possibility that none may be found between tension levels and gain, does not logically and statistically preclude the possibility that our hypothesis six above is true. This hypothesis is that recall as reminiscence (difference of ACH on Sessions 2 and 3) is greater when the individual's emotional state on the second occasion more closely resembles that on the first. This involves calculating a pattern similarity coefficient for each individual on his Seven State and SMAT score profile on first and later (recall) sessions.

(8) A second order dR factoring of state measures, i.e. an examination of the way in which levels on the eight states--fatigue, anxiety, etc.--covary from occasion to occasion.

Two of the above are at present under investigation, number (1) by Bartsch and Cattell and number (2) by Cattell, Barton, and Bartsch. Plans are being made among the three investigators also to preserve the data for analyses (3) and (4).

It must be said at this retrospective point that no apologies seem called for on anyone's part for the fact that not all the hypotheses we originally set up for testing have yet been examined. The data-gathering part of this

research was enormous--and complex! Probably there has seldom been gathered so many variables on so many subjects and so extensive a multivariate analysis undertaken. Obtaining five sessions of time from so many schools was itself a public relations task not easily consummated. The Long Term study was completed in every detail, and its results have already been made available in some 20 publications (below); but in the Short Term study, we were caught with the situation in which the last of the data could not be gathered in until the beginning of the last year. We, in fact, had just ten months in which to complete the scoring, make all analyses, and begin writing up. In spite of the full time dedicated work of Dr. Keith Barton and Dr. Tom Bartsch, and virtually the full time of the principal investigator, only some four out of ten proposed analyses could be completed in the time, before the team broke up in July, 1973.

The data from this research and the further possible analyses to be made from it, seem to us so valuable that every effort should be made to ensure completion. Unfortunately, our appeal for supplementary funds for this purpose, made by the principal investigator was turned down. Nevertheless, Barton, Bartsch, and Cattell have continued with at least two of the above further analyses, as stated, and it is greatly to be hoped that Drs. Barton and Bartsch (Dr. Cattell having retired from the University) will be granted (perhaps under the Small Grants scheme) enough to help them complete under more favorable conditions certain specifically defined analyses from material which Professor Cattell has so far been able to keep in well recorded storage at the University of Illinois.

IV SUMMARY

This study of Effects of Personality, Motivation, and Reward on Learning attacked the problem in two main ways: (1) What has been called the Long Term Study, which studied school achievement and gain in school achievement over a one year period, taking four major, representative areas of school study, and (2) The Short Term Study which took a single lesson period and planned to relate learning not only to fixed personality and motivation traits, as in (1), but also to emotional state at the time, stimulation of arousal, level of fatigue, amount of contingent, non-contingent, immediate, and delayed reward, and changes of motivation level during the learning and recall (over a two week interval).

The results of the Long Term study were statistically significant in support of virtually all hypotheses we had started with from previous researches. Culture fair and traditional intelligence tests, measuring respectively fluid and crystallized intelligence, had the expected magnitudes of relationship (centering on 0.5). The personality factors of super ego strength (G) and self sentiment (Q_3)--for the seventh grade--had the usual magnitude of positive association, and ego strength (C), affectia (A), premsia (I), asthenia (J), and guilt proneness (O) had consistent relations across all four subjects, but specific to a class. The motivation traits, measured by SMAT, also had the hypothesized relations, e. g. positive on sentiment to school, super ego, self-sentiment to school, super ego, self-sentiment, fear, pugnacity, and home sentiment, but in the integrated component only. Integrated and unintegrated measures of motivation frequently acted, as the dynamic calculus would expect, in opposite directions.

The prediction of gain score over the year, on the other hand, was less successful, significant results being found only for two or three second order personality factors. We conclude that the best psychometric treatment of gain

scores has not yet been achieved. On the absolute level over the year, however, our conclusion--contrary to much that is written in educational psychological reviews of this field--is that substantial gains in prediction result from adding personality and objective motivation measures to the predictors previously from ability alone. Indeed, our results in the main definitely support the findings in The Prediction of Achievement and Creativity by Cattell and Butcher, that (a) the ability, personality, and motivation measures are substantially mutually independent (except for super ego and self sentiment being factors both in the questionnaire and the objective motivation measurement media), (b) each contributes equally and therefore about a third, of the predicted variances on the criterion, and (c) together they account for from 51-76% of the achievement variance, depending on the school subject concerned.

Further, analyses were made showing significant relations also between child personality, parental attitudes, and child rearing practice factors. All the above results are already set out in detail in some 20 articles published or accepted for publication.

In the Short Term study, some 2500 sixth and seventh grade boys and girls were given standard video lessons on (a) Driver Safety, and (b) Care of Pets. They were measured on the same traits as in the Long Term study (intelligence, 14 personality factors, 20 motivation factors), and also on each of seven psychological state factors, at the time of learning and recall, in a design with five sessions (only three taken by any one group). Additionally, there were manipulations covering (a) inducing changes in arousal and fatigue, by music and time of day, (b) varieties of reward and non-reward for the learning recorded after the lesson, covering contingent and non-contingent, immediate and delayed reward, conveyed by dollar bills. Practical difficulties forced the experimenters to abandon the plan--that each S would know which items he

had answered correctly and which incorrectly and this alters the situation from that in the typical learning experiment, since S's are now rewarded for effort rather than correct results, and the effect is on consolidation of learning (reminiscence effects) rather than on a second learning opportunity.

An analysis of variance in terms of nine effects ran into interpretive difficulties owing to the large numbers of interactions in relation to degrees of freedom. However, various sub-analyses were made before the expiration of funds and the dispersal of the research team stopped further analyses on this extensive and carefully recorded body of measures in a complex design.

The lessons produced highly significant increments between pre- and post-tests of achievement; but no significant differences were found for the diverse reward effects. Analyses of intermediate effects showed that state measures on anxiety, depression, stress, and regression increased significantly with later hour of day. There were sex interaction effects, girls having a higher arousal level than boys but decreasing significantly during the day. The increase in fatigue was also significantly greater for girls than boys. A curiosity of these results was that martial music, intended to increase arousal (which it did) also produced a significant increase in depression score on boys but not girls.

The analysis of the effect of arousal and fatigue levels (as manipulations and as scale-measured states) and of the remaining five states, upon achievement, has been undertaken since the termination of the study, by Barton and Cattell, and it can be said at this point only that about half of the possible relations are statistically significant. Bartsch and Cattell are continuing analyses also with respect to interactions in the relation of recall improvement to reward, and in regard to predictions of learning rate in a single lesson to the individual difference trait measures found predictive in the Long Term study.

A statement of hypotheses still remaining to be tested by this data, and of the variables needing to be statistically related to examine these hypotheses, has been set out systematically above. It is planned, in view of the probably unrivalled completeness of data and size of sample in this area, for Drs. Barton, Bartsch, and Cattell to continue in association in these analyses, to the extent that individual resources and further aid permit.

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